OCCASIONAL PAPER 115 NOVEMBER 1950

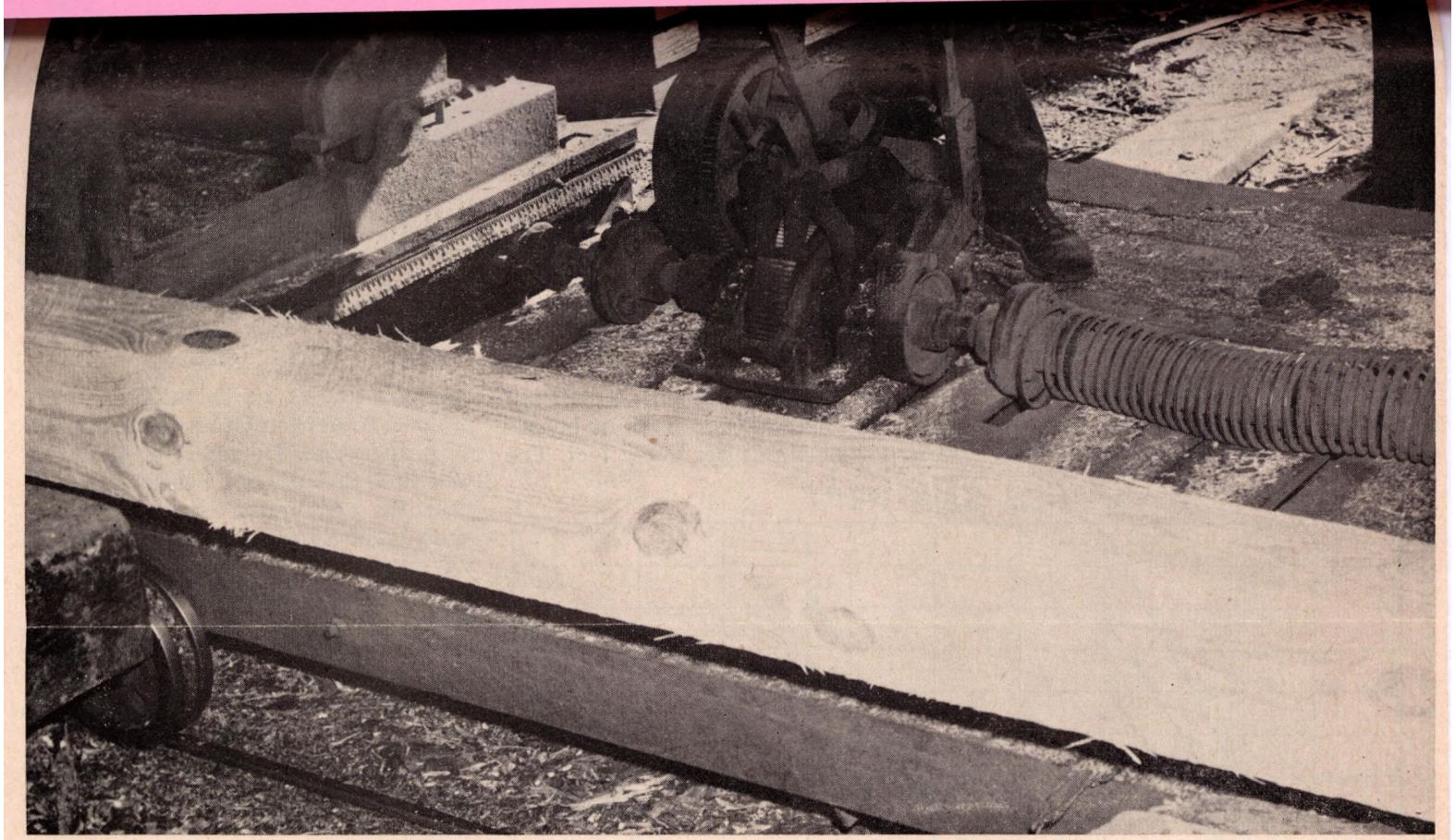
Grosenbaugh

AMOUNT OF CHIPPABLE WASTE
AT SOUTHERN PINE SAWMILLS

By
Roswell D. Carpenter

SOUTHERN FOREST EXPERIMENT STATION
Chas. A. Connaughton, Director
New Orleans, La.
FOREST SERVICE, U.S. DEPT. OF AGRICULTURE

AGRIC - ATLANTA



BOARDS or CHIPS?

By Don Fassnacht

Southern Forest Experiment Station
Forest Service, U. S. Department of Agriculture

Not long ago, a sawmill man said, "You buy the logs, run my sawmill, and sell the lumber, and I'll give you the whole she-bang—if you'll give me the chips from the waste. He was joking, but there was a "new-papa" glint in his eye when he looked at his new barker and chipper, and at the screened chips blowing into shiny vans.

Chipping sawmill residues is becoming as much a part of the Southern sawmill business as turning the logs on the carriage. About 750,000 tons of chips will flow from sawmills to pulpmills this year. As increased costs pinch profits against levelled selling prices, more than one sawmill man is taking a second look at the low-grade heart center of the log and wondering whether, instead of increasing his inventory of low-value lumber, he might not do better to send the knotty center cant into the chipper along with the barked slabs and edgings.

Not an Easy Decision

Deciding whether a board or its chips will yield the greater return is not too easy for the average sawmill operator. If he were to chip the board after it was sawn and trimmed, the problem would be simpler, but he would sacrifice the considerable gain obtained by turning the sawdust and end-trim into chips.

In order to make a decision, the operator must have a pretty good idea of his present returns from both chips and lumber. If he knows his net return per thousand board feet of low-grade lumber and also what he makes on a ton of chips, and if he will take the trouble to weigh and measure a few fresh-cut boards, he can arrive at some reasonable assumptions as to where his greater profits will be found.

Moisture content and specific gravity of wood, saw-kerf, log trim allowance, and chipping losses will vary with every log and every operation, but these difficulties can be overcome by applying some avearge values. For our purposes, we will assume that all lumber is cut full size, 4/4 sawn exactly one inch thick, 8/4 exactly two inches thick, and so on. Both ¼-inch and ⅜-inch saw kerfs will be considered so that the common range of saw-tooth size will be represented.

A four-inch trim allowance will also be assumed, since it is something of an average for the industry. This results in about a three per cent gain for every unsawn board on the cant. A four inch trim allowance is exactly four per cent of an untrimmed eight-foot board, and two per cent of a sixteen-foot board. Hence, three per cent seems to be a reasonable approximation.

In chipping and screening, wood is lost in fines and over-size. At sawmill installations, this loss averages about three per cent, thereby cancelling out the gain from the trim allowance. Thus, the sawdust remains the main "gain" from "not sawing" our boards. Table 1 shows this gain for several common thicknesses of pine lumber.

Having converted the "unsawn" board foot to cubic feet for chips, the operator's next problem is to determine the weight of a cubic foot of his wood. This he must do for himself. Probably the average for green Southern pine will run between 55 and 65 pounds per cubic foot. Actually weighing a few

Table 1.—Cubic feet of wood that can be chipped from an "unsawn" board foot of lumber

Thickness of "unsawn" lumber (inches)	Gain from sawdust	Equivalent wood for chips[1]
	Per cent	Cubic feet
	¼-inch kerf	
4/4	25.00	0.10416
8/4	12.50	.09375
12/4	8.33	.09027
	⅜-inch kerf	
4/4	37.50	.11458
8/4	18.75	.09895
12/4	12.50	.09375

[1]Based on: 1 board foot equals 0.08333 cubic feet.

square-cut boards right from the saw, and carefully measuring width, thickness, and length, will give a sample accurate enough for most purposes. (The width in inches times the thickness in inches times the length in feet divided by 144 yields the number of cubic feet in the piece. For example, a full-cut 1-by-6, 12 feet long, contains one-half cubic foot and will weigh thirty pounds if the wood weighs 60 pounds per cubic foot.)

With this information in hand, the sawmill operator can use Table 2 to decide whether boards or chips will yield him greater profits.

As an example, assume a sawmill cuts a ⅜-inch kerf and finds its boards average 60 pounds per cubic foot. The operator knows he is making a net profit of $3 per ton on his barking-chipping operation. By using Table 2, he will find that all 4/4 boards removed from the cant must be of such grade as to yield a net profit of $3.45 per M for every dollar of his net profit per ton of chips. Since his net profit on chips is $3 per ton, the cant should not be sawn unless the boards to be taken from it will net at least $10.35 per M ($3 x $3.45).

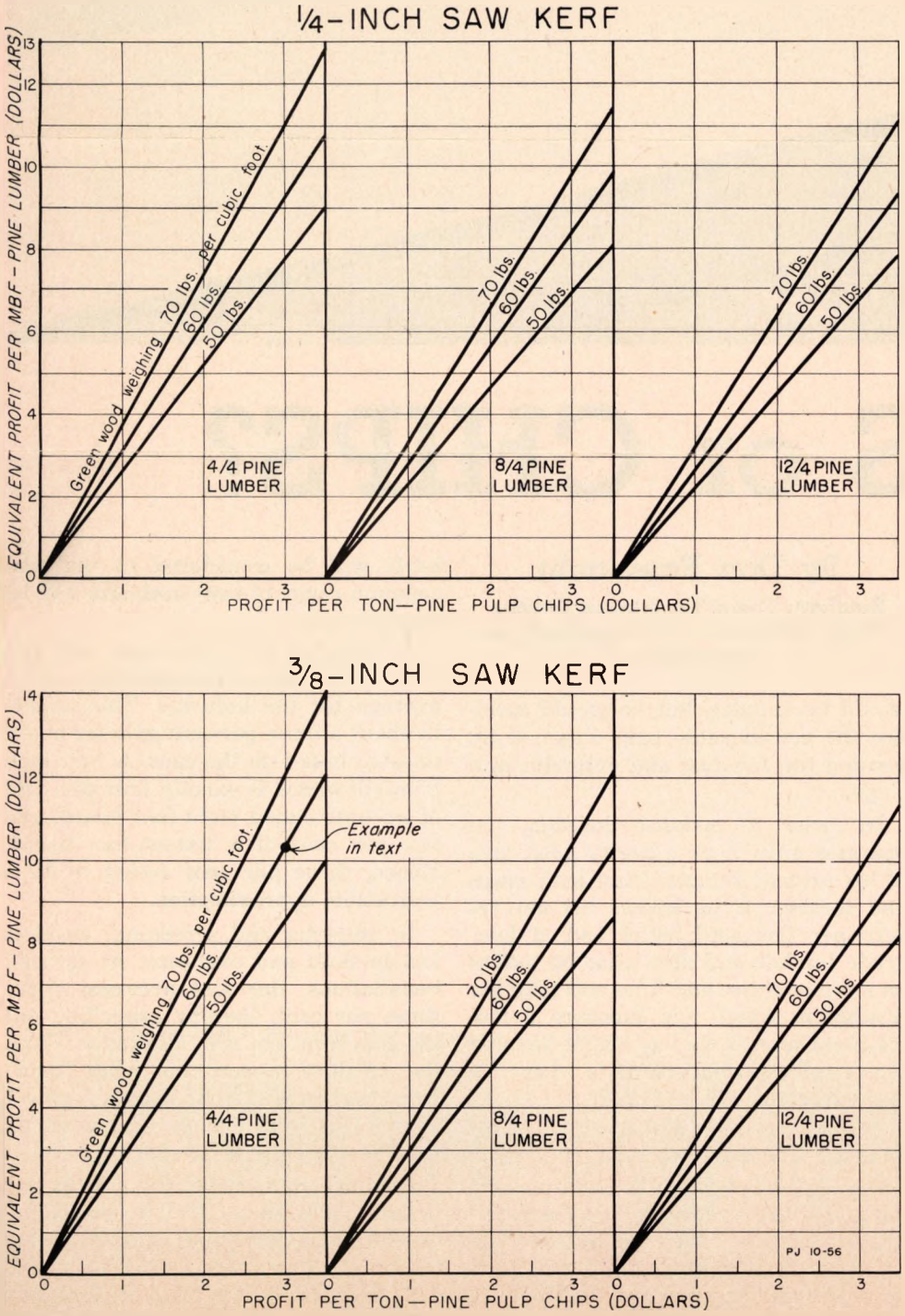


FIGURE 1.—*Equivalent values of boards (left on cant) and chips from cant.*

Table 2.—Equivalent net profit (rounded to nearest $0.05) of one thousand board feet of "unsawn" lumber if chipping yields a net profit of $1 per ton

Lumber thickness (inches)	Weight of a cubic foot of green wood 50 lbs.	60 lbs.	70 lbs.
		Dollars	
	¼-inch kerf		
4/4	2.60	3.15	3.65
8/4	2.35	2.80	3.30
12/4	2.25	2.70	3.15
	⅜-inch kerf		
4/4	2.85	3.45	4.00
8/4	2.45	2.95	3.45
12/4	2.35	2.80	3.30

Formula

All the relationships shown are arithmetical. Simple interpolation can be used for all differences in saw kerf, wood weight, and net chipping profit. For those who wish to compute the values directly (always remembering the rough assumptions used above), the following formula will serve:

$$P_b = \frac{(T_n + K)\ D\ P_c}{24\ T_n}$$

Where: P_b = Net profit (dollars) per M from boards of the lumber grade which the cant will yield

K = Saw kerf (inches)

T_a = Thickness of actual board (inches) as sawn.

T_n = Thickness of nominal board (inches).

D = Density or weight of cubic foot of green wood, in pounds.

P_c = Net profit (dollars) per ton from chipping operation.

For an easier means of visualizing these approximate relationships, Figure 1 shows equivalent values derived from Table 2. The dot in the chart for 4/4 lumber and ⅜-inch kerf shows the comparison used as an example above.

Of course, no final policy decision between boards and chips can be made from a single chart or formula. The most efficient and profitable relationships between the two forms of wood utilization have yet to be worked out by the industry under varying economic conditions. The procedure outlined above offers an opportunity for making preliminary decisions based on approximate values. The boss must always take it from there.

Reprinted from *Southern Lumberman*, issue of December 15, 1956.

Weight-Conscious Lumbermen

Sam Guttenberg and Joe D. Perry
Southern Forest Experiment Station
Forest Service, U. S. Department of Agriculture

Southern pine lumber producers, spurred by the problems incident to increasing competition for pine markets, and rising stumpage, labor, and machine costs are rapidly becoming weight conscious.

Weight is an old lumber-production problem. In part, past efforts to reduce shipping weights and thereby reach out to distant marketing centers helped to establish today's standard lumber patterns. The developing market for pulp chips is about to liquidate another weighty problem—the accumulation of heavy sawmill residues. Operators who have installed log barking and chipping equipment, or those about to, are as keenly interested in the price per ton of bark-free chips as they are in wholesale lumber prices.

Thanks to the pioneering efforts of forward-looking pine producers, the virtues of barking logs and chipping sawmill residues are now evident. Not so clear is the opportunity for disposing of lumber shorts and No. 3 Common and poorer lumber as market chips. Some operators are adept at converting shorts into specialty items at favorable margins and others market their 3 Common and poorer lumber with a minimum of pain. Still others find this class of material a perennial burden. For this latter group there is no simple answer as to which is the better alternative—cutting shorts and 3 Common and poorer lumber or producing pulp chips.

The choice between making lumber or chips depends on (1) the net value of chips recoverable from low-grade log centers and short jacket lengths before the extra lines are sawn, and (2) the lumber values in these same log portions adjusted for the extra sawing and handling costs involved in producing finished lumber.

Appraisal of Alternatives

An appraisal of these alternatives can be readily made at any mill equipped with barking and chipping machinery. Mills need to determine their own lumber-chip ratios because chip weight varies with specific gravity and moisture content, which in turn are influenced by species, site, and other factors.

The "Interim Log Grades for Southern Pine," which are available from the Southern Forest Experiment Station, New Orleans 13, Louisiana, are useful for separating out the low-quality logs in which problem lumber is concentrated. Even with graded logs, lumber values will vary from mill to mill because of differences in sawing practice, type of head-saw, and resawing equipment.

Direct comparison of the lumber and chip alternatives is perhaps the easiest appraisal method. This approach requires the mill manager to keep special cost-and-return records for about two weeks of operation. The first week's accounts are for sawing as usual. The second week is for sawing on a weight-conscious basis—that is, with shorts and low-grade log centers diverted to the chipper before the extra lines are sawn. The net returns from each method of operation can then be compared.

Although such a test gives an inexpensive rough-and-ready answer that may suffice for practical purposes, it has some shortcomings. It assumes that the log intake pattern in size and grade is fairly constant, and it provides little information for dealing with inevitable changes in the lumber and chip markets and in production costs.

Another Approach

A somewhat more useful approach was applied at the Reynolds and Draper mill near El Dorado, Arkansas. This mill is equipped with a Soderhamn D-3 barker, solid-tooth circular head-saw, vertical band resaw, edger, and Soderhamn HF-60 chipper.

A sample of 120 loblolly and shortleaf pine logs, 16 feet long, was drawn from current deliveries to the mill. These logs were sorted into piles according to scaling diameter and "Interim Pine Log Grade" as shown in Table 1.

The individual piles were handled as units throughout this study. Pile by pile the logs were barked, sawn into one-inch lumber, and the residues chipped. Each pile's lumber was scaled and graded on the green chain. Boards grading No. 3 Common or lower were set aside to be weighed as an estimate of their chip yield. Also marked were those pieces to be cut back for grade or wane. The net volumes of the low-grade lumber and the cut-backs over 18 inches long were weighed. The slabs and edgings were chipped and then weighed. This procedure established, for each pile, the net lumber yield by width, length, and grade, and the chip yield in pounds.

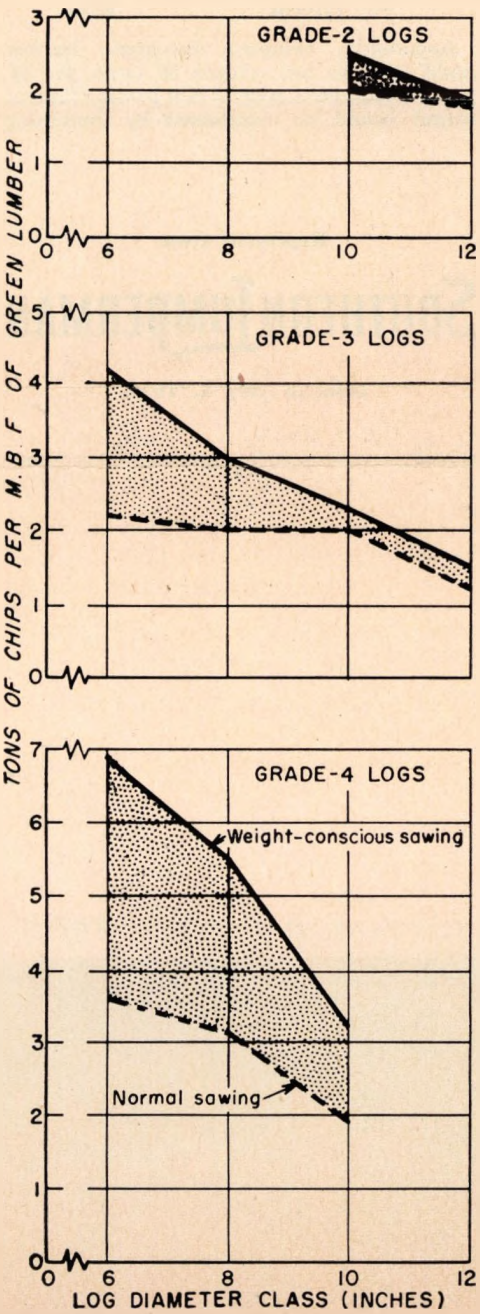


FIGURE 1.—*Tons of pulp chips per MBF green-chain tally, for normal and weight-conscious sawing.*

Table 1.—Distribution of logs by grade and diameter class

Log grade	Log diameter, small end: 6 inches	8 inches	10 inches	12 inches
	Number of logs			
2	....	....	15	3
3	15	15	15	12
4	15	15	15	....

As in studies elsewhere, chip yield per MBF of green lumber sawn increased as log size declined (Fig. 1). But the six- and eight-inch logs of Grade -4 quality produced substantially more chips than those in Grade 3. This difference is due, in part, to the efficacy of the log grades in separating small straight logs (Grade 3) from sweepy ones (Grade 4). Grade-4 logs also had, on the average, one inch greater taper than Grade-3's. The mean diameter of the Grade-4 logs was somewhat larger, too. Thus, the extra chip yield resulted from differences in log size, taper, and sweep.

At this mill, normal practice is to manufacture pulp chips rather than lumber shorts. Because the chipper got many pieces that could have made boards less than eight feet long, chip yields by log size were greater than that reported for similar mills in earlier studies. The shaded area between the solid and dashed lines of Figure 1 indicates how effectively the log grades point to the source of 3-Common lumber. Not only did most of the low-grade lumber come from logs scaling less than 10 inches but it tended to increase with declining log grade.

Table 2 shows the relative value of the lumber produced by log size and grade. The index numbers mean this: Suppose that No. 2 Common 1 x 8's (the index base) are selling for $80 per M. Then, under normal sawing, the mill value of lumber in six-inch grade-4 logs will be about $63.20 (.79 x 80) per M, while the lumber from 12-inch Grade 2 logs will sell for $138.40 (1.73 x 80). Table 2 also indicates the effect upon relative values of chipping low-grade material. For instance, when only No. 2 Common and Better is sawn, the average value of the lumber from six-inch Grade-4 logs increases from $63.20 per M to $71.20 (.89 x 80). Cutting dimension as well as boards would, of course, change the indexes, but the effect of log grade and size would still remain.

Chips Versus Lumber

The 120 logs were fairly typical of the usual mix of sizes and grades processed at the mill. On the average, they were Grade 3 and had a small-end diameter of nine inches. They sawed out 4,930 board feet, including 730 feet of 3 Common lumber. The average lumber index was 105. The chip yield was about two tons per MBF of green lumber cut. Data of this sort are basic for making the decision between chips and low-grade boards.

Normal sawing: Suppose that the current

TABLE 1—AVERAGE 1957 PRICES FOR ROUGH PULPWOOD BOLTS IN THE MIDSOUTH

Trucked to—	*Pine*	*Hardwood*
	Dollars per cord	
Rail sidings	15.10	13.21
Woodyards	15.30	12.79
Mill yards	15.83	14.30

rapidly as the demand for pulpwood. Further gains in chip output will come chiefly from increase in the average size of pine sawmills, greater stability in the industry, and further technological improvements—especially those pointed at utilizing the residues of small sawmills. Our 8 billion board-foot pine industry has a potential of some 4 million cords of chips annually. It took five years to get the first million cords, but because of the difficulties of bringing small mills into chip production, about 10 years may be needed for the second million.

Pulpwooders who suddenly found time to go fishing in late 1957 need not view the upsurge in chip use with alarm. Rough bolts are still the mainstay of the industry and will remain so for some time. The indications are for a short fishing season for pulpwooders. The Midsouth has the most favorable consumption and inventory balance among the producing regions. Too, much of the plant capacity is relatively new and efficient. Additional pulp capacity was opened up late in 1957 and more is scheduled for completion in 1958. The pulp industry is affected by general business conditions, but the Midsouth's competitive position is strong. It won't be long before pulpwooders will be establishing new records for rough bolts.

What about prices? Prices paid for chips and rough bolts were obtained from companies that utilized 78% of the 1957 cut.

Chips are marketed in a variety of ways. Some are merely moved between divisions of companies operating both pulp mills and sawmills. Others are subject to trading between mills, the pulp company offering sawtimber for chips. In open-market transactions, chips are chiefly sold by green weight, though some dry-weight trading is practiced.

In 1957, the average price per ton on the open market was $6.19 for green pine chips and $4.31 for hardwood. The lower price for hardwood is partly due to the much smaller volume (Fig. 1).

Average prices for rough bolts trucked to rail sidings, woodyards, and mill yards are given in Table I. As could be expected with volume down, prices eased somewhat. Pine and hardwood bolts trucked to mill yards were worth 4% less per cord than in 1956. The rail siding and woodyard prices are not directly comparable with those reported in this periodical last year (SOUTHERN PULP AND PAPER MANUFACTURER, Sept. 10, 1957, p. 44). Last year rail-wood prices were a blend of rail-siding and woodyard deliveries. When allowance is made for this difference, the price for these classes of bolts declined less than 2%. These percentages probably understate the extent of the decline per cord, for the data are based on averages for all of 1957 and most of the decline in production and prices occurred late in the year.

Reprinted from
SOUTHERN PULP *and* PAPER MANUFACTURER
75 Third Street, N. W., Atlanta 8, Georgia
October 10, 1958

Chips Bolster Midsouth Pulpwood Cut in 1957

By SAM GUTTENBERG
Southern Forest Experiment Station
Forest Service, U. S. Department of Agriculture

Pine lumbermen of the Midsouth doubled their output of pulp chips in 1957 to account for 9% of the pine delivered to pulp mills. The huge gain was made while overall pulpwood production declined 3% to 8.8 million cords—the first time in eight years that a new production record was not established. Nearly all the shrinkage was in pine, the rough bolt cut being off 8.5% from 1956.

While chip producers had no marketing problems, paper products salesmen had to convert from order-taking to selling. Buyers were assured prompt delivery as mills operated below capacity. Why the favorable market behavior for chips in an off year, and where did the chips come from?

To answer the last question first, the chips came mainly from large pine sawmills in the Midsouth. Aided by technological developments and encouraged by the paper industry, these mills have raised their chip output from scratch to ¾ million cords in just five years (Fig. 1). The Southeast, with fewer large sawmills, produced somewhat more than 300,000 cords last year.

Chips are rapidly becoming a widely accepted lumber grade. They add between $7 to $12 to mill receipts for every MBF of lumber sawed, and they are made chiefly from material that would have little or no other sales value. At the larger mills, these receipts are had at favorable margins over costs.

Today, more and more lumbermen are realizing that chipping their mill residues is essential to profitable operation. The chips are one of a number of joint products from sawlogs, and much of their cost is chargeable to the various lumber items. Hence, chips from residues are much less costly—especially of labor use—than those from rough bolts. So it isn't surprising that chip production boomed in a year when output of round pulpwood declined.

If chips could be more plentiful, they would be even tougher competitors of round wood. But the market for lumber sets the limit on residue chips, and lumber production is not likely to increase as

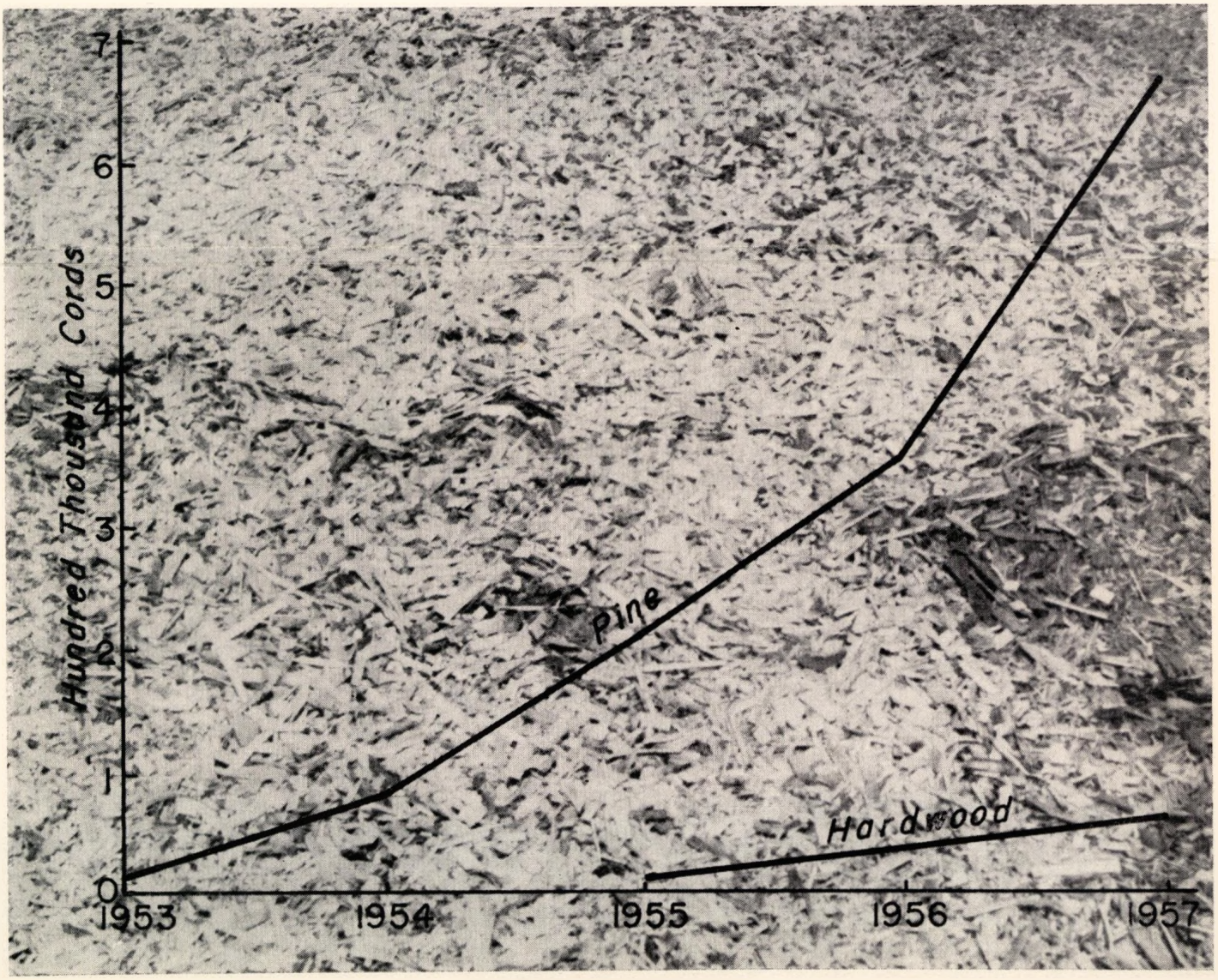


Fig. 1. Midsouth chip production.

Reprinted from
SOUTHERN PULP *and* PAPER MANUFACTURER
75 Third Street, N. W., Atlanta 8, Georgia
October 10, 1958

Table 2.—Lumber value by log grade and diameter

Type of sawing	Grade-2 logs		Grade-3 logs			Grade-4 logs		
	10 inches	12 inches	6 inches	8 inches	10 inches	12 inches	6 inches	8 inches	10 inches
	Index per MBF								
Normal sawing	157	173	85	100	118	107	79	90	98
Only No. 2 Common and Better lumber sawn	163	177	98	109	122	110	89	97	104

price of No. 2 Common 1x 8 boards is $80 per M, while production cost runs about $85 per M. The net return on chips is estimated at $3 per ton. Then:

	Dollars per MBF
1.05 x 80	$84.00
Lumber production cost	85.00
Lumber margin	—1.00
2 tons of chips at $3	6.00
Net returns	$5.00

Weight-conscious sawing: Logs that under normal sawing yield 1,000 feet of lumber would under weight-conscious sawing net 855, for 145 feet of potential low-grade lumber would be chipped. Since the chip yield under weight-conscious sawing would be 2.6 tons per MBF (Fig. 1), the production of 855 board feet would net 2.2 tons (2.6 x .855) of chips. Lumber value index would rise to about 115, reflecting the prices of No. 2 Common and Better. Production costs would remain the same through the head-saw but after that some savings would accrue because 145 fewer board feet would have to be resawn, dried, and finished. Total cost might thus be about $80. Then as before and for the same *log volume* that yields 1,000 board feet under normal sawing:

	Dollars
1.15 x .855 x 80	$78.66
Lumber production cost	80.00
Lumber margin	—1.34
2.2 tons of chips at $3	6.60
Net returns	$5.26

Apparently, chipping low-grade lumber could increase net returns 26 cents per M. These calculations assume that present lumber output would be maintained by increasing log in-take so that overhead costs would be unaffected.

Margins are likely to vary with changes in the lumber and chip markets, and with production costs. Information on how log size affects logging and milling costs is also useful. Data of this nature might show that some tree bole sections might best be sold as pulpwood bolts.

In the future, the mill manager who knows his yield ratios for lumber and chips as related to log size and grade will be best able to choose a sound course of action in the face of changing market prices and costs. Needless to say, the chipping decision must be made before the lumber is dried, and preferably even before the extra lines are sawn.

Although this may not happen tomorrow or the day after, it is possible to foresee Southern pine lumber producers scanning lumber and chip prices along with their breakfast coffee. Riding to work, they spin their handy computers in comparing these alternatives—no longer in terms of MBF but per ton. Arriving at the plant with the problem solved, our operators of the future flick loud-speaker switches and throughout the plant is heard, "Now hear this! Now hear this! Orders for the day—saw all logs down through Number 2 Common lumber and shunt the remainder to the chipper along with all odds and ends less than eight feet long."

Reprinted from

SOUTHERN LUMBERMAN

issue of July 1, 1957.

AMOUNT OF CHIPPABLE WASTE AT SOUTHERN PINE SAWMILLS

By
Roswell D. Carpenter
Southern Forest Experiment Station

This paper summarizes the results of a study of the amount of wood waste, suitable for pulp chips, produced at four different classes of southern pine sawmills. The study, carried out between October 1948 and February 1950, was made cooperatively by the Southern Kraft Division of the International Paper Company and the Southern Forest Experiment Station.

Study Methods

Results were obtained at 16 sawmills in northern Louisiana and in southern and central Arkansas. On the basis of their sawing equipment, the mills were divided into four classes:

Class 1	Band headsaw with resaw
Class 2	Solid-tooth circular headsaw with resaw and shotgun carriage feed
Class 3	Solid-tooth circular headsaw with steam feed (small gun); no resaw
Class 4	Portable mill with circular headsaw using inserted bits; no resaw

Two mills of each class were in Arkansas and two in Louisiana.

Most of the study logs were loblolly and shortleaf pine. At some of the mills, a few longleaf logs were included. All logs were peeled before sawing. Practically all of the logs came from second-growth timber, and the volume of heartwood was so small that it was included with the sapwood in computing the waste.

At each of the mills, an attempt was made to secure data on waste from the number of logs indicated in the tabulation at the right. Only one log was obtained in the two largest diameter groups. In the other diameter groups, it was not possible to get the desired number of logs at every mill, but enough were studied to assure statistically reliable results and to give a sound basis for comparisons between classes of mills.1/

Diameter group (inches)	Scaling diameters included	Logs desired
	Inches	Number
6	4.51 to 6.50	20
8	6.51 to 9.50	50
11	9.51 to 12.50	50
14	12.51 to 15.50	50
17	15.51 to 18.50	20
20	18.51 to 21.50	20
23	21.51 to 24.50	5
26	24.51 to 27.50	5
29	27.51 to 30.50	5

The procedure for determining the amount of waste was the same at each mill. Logs were peeled by hand and then segregated by diameter groups. For each log the average diameter was taken to the nearest 1/10 inch at the small end, middle, and large end. All diameter measurements were taken inside bark with calipers. Length was measured to the nearest 1/10 foot with a steel tape. Net Doyle scale, inside bark, was recorded. Logs were reduced in volume for sweep in excess of 2 inches and for rot, fire scars, and other deductible defect; and those under 8.5 inches in diameter were given a scale equal to their length. The volume in cords of waste per thousand board feet has not been adjusted to a base of 16-foot log length because the average log length of both the study logs and those found in a subsequent analysis of the annual log intake closely approached this figure.

The peeled logs in each diameter group were weighed to the nearest 5 pounds.

The logs were put through the sawmill by diameter groups and data were recorded separately for each group. A piece tally of the lumber by length, width, and thickness was made by the sawmill's lumber grader. Six samples of the green wood were taken at random from the sapwood portion of the lumber in each diameter group, and the moisture content was determined by the oven-dry method.

1/ Tables of the standard error and standard error in percent of the mean of the waste in cords by mill classes for Arkansas and Louisiana show fairly consistent results. For all mill classes, the greatest error is in the 8- and 11-inch diameter groups.

All slabs, edging strips, and end trim from each group were collected and weighed immediately after sawing. For at least two mills in each class, the waste was then sorted into chippable and non-chippable material. For the purposes of the cooperators, non-chippable material consisted of thin, ribbon-like pieces of edging strips and all heavier material less than one foot long. The amount of such material varied by diameter classes (see footnote to table 4, page 7) but averaged only 6 percent of the total heavy waste. Weight or volume of sawdust was not determined. The data on heavy waste were computed in terms of weight and then converted, taking 2,500 pounds of oven-dry wood as the equivalent of one cord.

This phase of the study gave the volume of waste for the study logs only. In order to determine the total volume of waste produced by the different study mills, it was necessary to determine the log intake pattern (by diameter and length) for the individual mills. This information was obtained from a study of each mill's log scale sheets for each tenth sawing day throughout the first half of 1948.

Amount of Waste

The amount of chippable waste produced per thousand board feet, green lumber tally, was 0.43 cord for class 1 mills, 0.46 cord for class 2 mills, and 0.61 cord for mills in classes 3 and 4. In 1948, the average study mill in class 1 or 2 cut about 8,000 M board feet of pine lumber, and thus produced about 3,500 cords of chippable waste. Class 3 study mills, with an average annual cut of 4,800 M board feet of pine, had 2,900 cords of heavy waste; and class 4 mills, with only half the lumber output of the class 1 mills, still produced over two-thirds as much waste. The volume of chippable waste for the study mills, as calculated from the 1948 log intake records, is shown in table 1.

Table 1.--Waste production at 16 study mills, 1948

Mill class	Lumber production	Chippable waste	Chippable waste per M b.f.
	M b.f. green lumber tally	Cords	Cords
1	32,465	13,992	0.43
2	31,949	14,601	.46
3	19,218	11,742	.61
4	15,836	9,676	.61

The main factor governing the amount of waste produced proved to be the diameter of the logs being sawed. Mill class was a secondary influence. The production of waste by log diameter and mill class is shown in table 2.

Table 2.--Chippable waste per M board feet, green lumber tally, from study logs

Diameter group (inches)	Mill class			
	1	2	3	4
	------ Cords ------			
6	0.76	0.81	0.90	0.69
8	.62	.54	.77	.82
11	.47	.43	.46	.57
14	.36	.35	.33	.40
17	.31	.28	.29	.24
20	.33	.24	.27	.27
23	.34	.19	.26	.25
26	...	.14	...	...

In mills of all classes, small logs produced the most waste and large logs the least. With a few minor exceptions, the proportion of waste for all mill classes decreased regularly as log diameter increased. Thus, in the log diameter groups between 6 and 23 inches, the waste factors in cords per thousand board feet, green lumber tally, declined from 0.76 to 0.34 cord for class 1 mills; from 0.81 to 0.19 cord for class 2 mills; and from 0.90 to 0.26 cord for class 3 mills. In class 4 mills, the waste factor rose from 0.69 cord in 6-inch logs to 0.82 cord for 8-inch material, but then declined to 0.25 cord at 23 inches.

For most diameter groups, class 2 mills produced less waste than mills of other classes. Class 4 mills produced somewhat more waste than other mills in logs from the 8-, 11-, and 14-inch diameter groups. These groups are the ones from which all classes of study mills drew the greatest volume of wood. The log intake patterns (the percentages of green lumber tally produced from logs of specified diameter groups) for the mills of various classes are shown in table 3. The table shows that mills in classes 2, 3, and 4 get about 95 percent of their cut from logs less than 15.5 inches in diameter. Mills in class 1 get only 82 percent of their cut from logs of these sizes.

Table 3.--Percent of 1948 green lumber tally produced from logs of specified diameter groups, by mill class

Diameter group (inches)	Mill class			
	1	2	3	4
	------ Percent ------			
6	1.2	2.7	8.1	2.9
8	13.8	33.9	43.7	32.6
11	35.1	41.5	33.6	42.3
14	32.1	17.0	11.0	16.0
17	13.2	4.0	2.5	5.3
20	4.2	.6	1.0	.8
23	.4	.3	.1	.1
	100.0	100.0	100.0	100.0

As is evident from the overrun figures in table 4 (column 6), mills in classes 1 and 2 usually get more lumber from a log of given diameter than do the mills in classes 3 and 4. This extra output stems from the fact that class 1 and 2 mills have thinner headsaws as well as resaws, and therefore cut less kerf than mills in the other classes. In evaluating the performance of the class 1 mills, it should also be remembered that they cut more 1-inch boards and less 2-inch dimension lumber than class 3 and 4 mills.

Figure 1 charts the performance of the various mill classes on logs of different diameter groups. Table 4 gives factors for total waste and other information on the study logs.

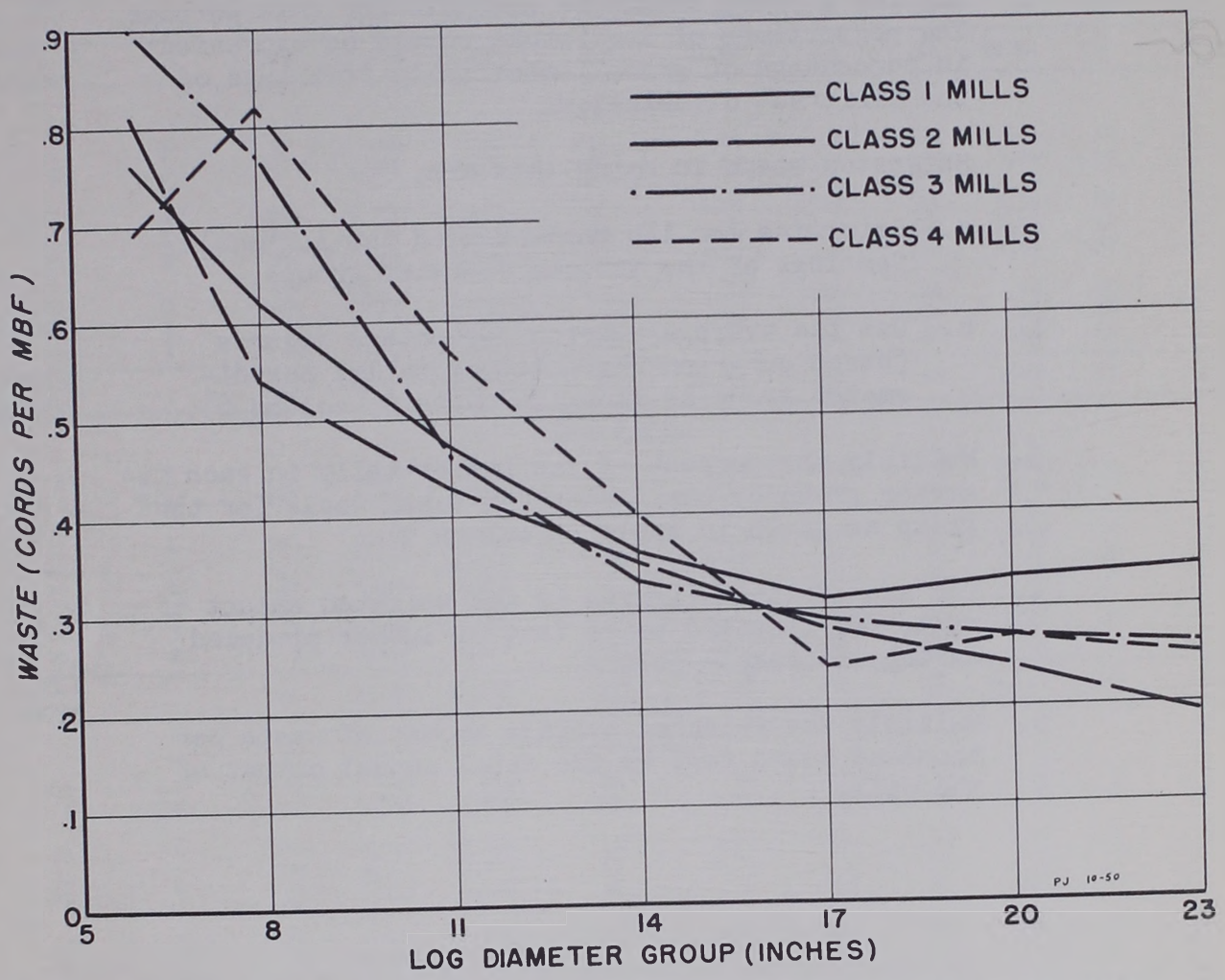


Figure 1.--Average amounts of chippable waste (in cords of waste per M board feet, green lumber tally) produced by study mills.

Application of Results

The waste factors developed in this study may be used to predict, with reasonable accuracy, the production of total heavy wood waste at most mills cutting southern pine timber. The steps in calculating wood waste are:

1. Place mill in its appropriate class.

2. Determine the percentage of annual log intake that comes from each of the diameter groups used in the present study. The records for every tenth sawing day for 6 months, or for every twentieth sawing day for a year, should be adequate for this purpose. The proportions of log intake should be expressed in percentage of green lumber tally from logs of the different diameters.

   Suggested steps in doing this are:

   a. Determine for the above period the log scale for logs of the various diameter groups.

   b. Use the average overrun percentage figures (based on green chain lumber tally) per diameter group as shown in table 4 (column 6).

3. Multiply the percent of the lumber tally in each diameter group by the factor for total waste for that group as given in table 4 (column 9).

4. The sum of these figures is the weighted amount of waste per thousand board feet of lumber produced during the sample period.

5. Multiply the weighted average amount of waste per thousand board feet by the total annual output of the mill.

Table 4.--Total and chippable pine waste from study logs

Diameter class (inches)	Mills	Logs	Net scale, Doyle	Green lumber tally	Overrun, based on green chain lumber tally	Total waste 1/,2/	Total waste per M b.f. 2/		Chippable 2/,3/		
										Waste per M b.f.	
							Doyle scale	Green lumber tally	Total chippable	Doyle scale	Green lumber tally
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	-- Number --		-- Bd. ft. --		Percent	---------- Cords ----------					
Class 1 Mills											
6	2	53	782	763	-2	0.60	0.76	0.78	0.58	0.74	0.76
8	4	197	3,713	6,943	87	4.45	1.20	.64	4.27	1.15	.62
11	4	205	9,288	14,611	57	7.29	.78	.50	6.93	.75	.47
14	4	201	18,125	24,596	36	9.41	.52	.38	8.75	.48	.36
17	4	93	14,212	16,669	17	5.73	.40	.34	5.22	.37	.31
20	4	41	9,211	10,142	10	3.68	.40	.36	3.35	.36	.33
23	2	7	2,187	2,179	0	.82	.38	.38	.75	.34	.34
Total or average	...	797	57,518	75,903	32	31.98	.56	.42	29.84	.52	.39
Class 2 Mills											
6	3	48	678	755	11	.63	.93	.84	.61	.90	.81
8	4	251	4,652	9,297	100	5.27	1.13	.57	5.06	1.09	.54
11	4	226	9,725	14,919	53	6.70	.69	.45	6.36	.65	.43
14	4	167	14,796	18,312	24	6.94	.47	.38	6.45	.44	.35
17	3	35	4,896	5,664	16	1.72	.35	.30	1.56	.32	.28
20	2	19	3,812	3,862	1	1.00	.26	.26	.91	.24	.24
23	2	4	1,147	1,147	0	.24	.21	.21	.22	.19	.19
26	1	1	331	301	-9	.04	.14	.15	.04	.12	.14
Total or average	...	751	40,037	54,257	36	22.53	.56	.42	21.21	.53	.39
Class 3 Mills											
6	4	76	1,159	1,480	28	1.37	1.18	.92	1.32	1.14	.90
8	4	287	5,195	8,957	72	7.21	1.39	.80	6.92	1.33	.77
11	4	230	9,686	13,520	40	6.52	.67	.48	6.19	.64	.46
14	4	156	13,667	16,079	18	5.66	.41	.35	5.27	.38	.33
17	4	62	9,056	9,701	7	3.09	.34	.32	2.81	.31	.29
20	3	47	10,006	10,156	1	3.04	.30	.30	2.77	.28	.27
23	2	5	1,498	1,370	-9	.40	.26	.29	.36	.24	.26
Total or average	...	863	50,267	61,263	22	27.28	.54	.44	25.64	.51	.42
Class 4 Mills											
6	2	37	510	693	36	.49	.96	.70	.48	.94	.69
8	4	252	4,361	7,750	78	6.64	1.52	.86	6.39	1.46	.82
11	4	212	8,849	12,620	43	7.60	.86	.60	7.23	.82	.57
14	3	105	8,574	10,542	23	4.56	.53	.43	4.24	.50	.40
17	3	23	3,113	3,497	12	.94	.30	.27	.86	.28	.24
20	2	22	4,122	3,977	-4	1.16	.28	.29	1.06	.26	.27
23	1	6	1,542	1,354	-12	.37	.24	.27	.34	.22	.25
Total or average	...	657	31,071	40,433	30	21.76	.70	.54	20.59	.66	.51

1/ Moisture content of all material in this study was 50.51 percent of green weight and varied between extremes of from 34.73 to 61.34 percent. Calculated by the lumberman's method, the moisture content of all material was 102.05 and varied between extremes of 53.20 and 158.66.

2/ Minor discrepancies between means and totals are due to the fact that sufficient significant digits are not carried in the means.

3/ The proportion of total waste that was chippable was 97 percent for 6-inch logs, 96 percent for 8-inch logs, 95 percent for 11-inch logs, 93 percent for 14-inch logs, and 91 percent for 17+-inch logs. For all study logs combined, the proportion was 94 percent.